Fig.1

Electronic Control Unit

1 2 4 24 25 22 20 5 23 32 31 7 21 3 11 15 12 14 13 6 9 10 8 35

Fig.2

Exhaust Valve

Intake Valve

Crank Angle

← Advance

Delayed →
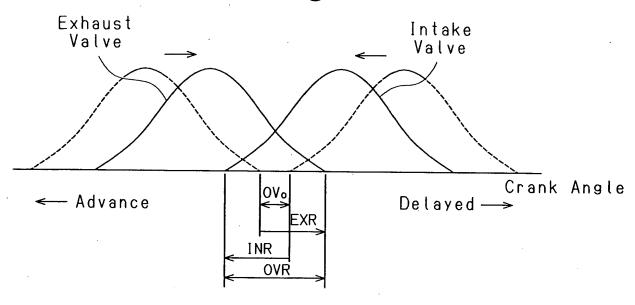
OV_0

EXR

INR

OVR

Advance
(in the direction of expanding valve overlap)

Fig.3(a)
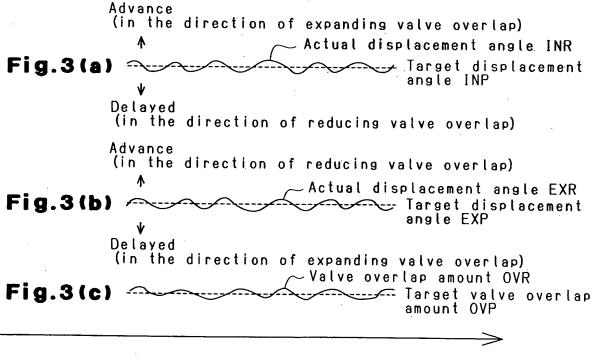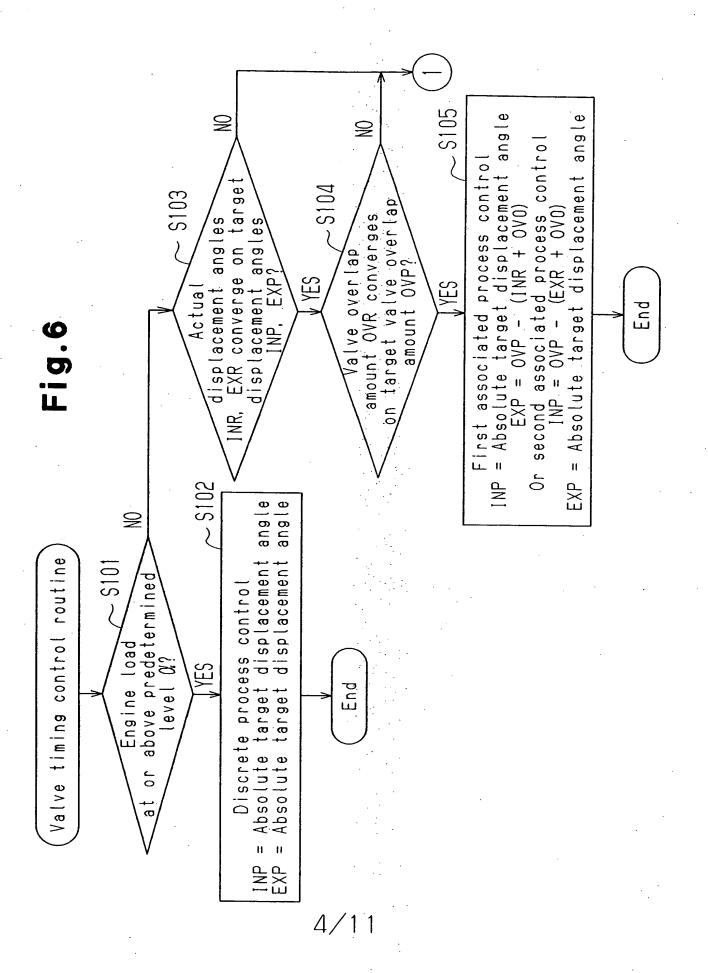
Actual displacement angle INR

Target displacement angle INP

Delayed
(in the direction of reducing valve overlap)

Advance
(in the direction of reducing valve overlap)

Fig.3(b)

Actual displacement angle EXR

Target displacement angle EXP

Delayed
(in the direction of expanding valve overlap)

Fig.3(c)

Valve overlap amount OVR

Target valve overlap amount OVP

Time

Fig.4(a)

Advance
(in the direction of expanding valve overlap)

Actual displacement angle INR

Target displacement angle INP

Delayed
(in the direction of reducing valve overlap)

Fig.4(b)

Advance
(in the direction of reducing valve overlap)

Actual displacement angle EXR

Target displacement angle EXP

Delayed
(in the direction of expanding valve overlap)

Fig.4(c)

Valve overlap amount OVR

Target valve overlap amount OVP

Time

Fig.5(a)

Advance
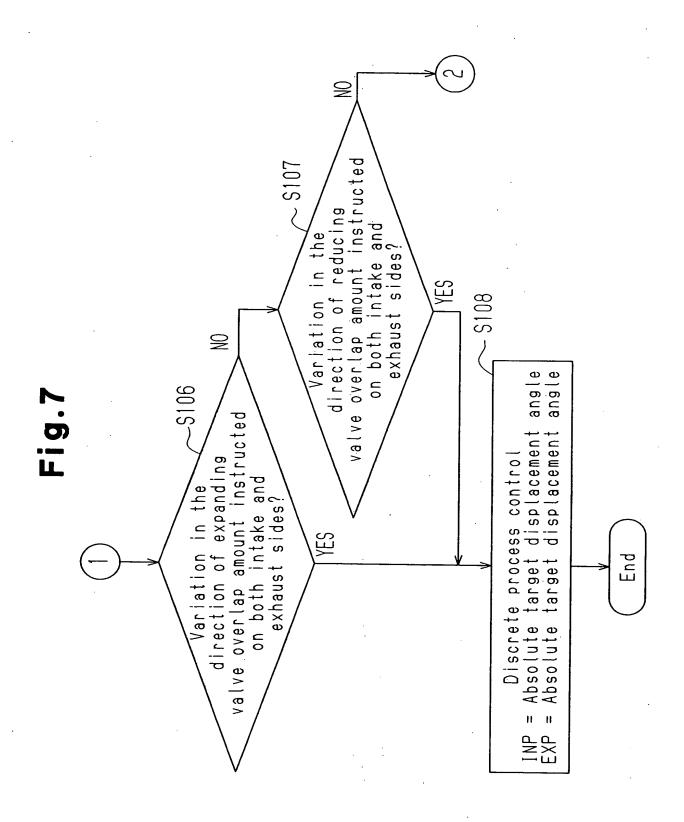(in the direction of expanding valve overlap)

Actual displacement angle INR

Target displacement angle INP

Delayed
(in the direction of reducing valve overlap)

Fig.5(b)

Advance
(in the direction of reducing valve overlap)

Actual displacement angle EXR

Target displacement angle EXP

Delayed
(in the direction of expanding valve overlap)

Fig.5(c)

Valve overlap amount OVR

Target valve overlap amount OVP

Time

Fig.6

Valve timing control routine

S101 — Engine load at or above predetermined level α?

YES → S102 — Discrete process control
INP = Absolute target displacement angle
EXP = Absolute target displacement angle
→ End

NO → S103 — Actual displacement angles INR, EXR converge on target displacement angles INP, EXP?

NO → ①

YES → S104 — Valve overlap amount OVR converges on target valve overlap amount OVP?

NO → ①

YES → S105 — First associated process control
INP = Absolute target displacement angle
EXP = OVP − (INR + OVO)
Or second associated process control
INP = OVP − (EXR + OVO)
EXP = Absolute target displacement angle
→ End

Fig.7

S106 Variation in the direction of expanding valve overlap amount instructed on both intake and exhaust sides?

NO

S107 Variation in the direction of reducing valve overlap amount instructed on both intake and exhaust sides?

NO → ②

YES

YES

S108

Discrete process control
INP = Absolute target displacement angle
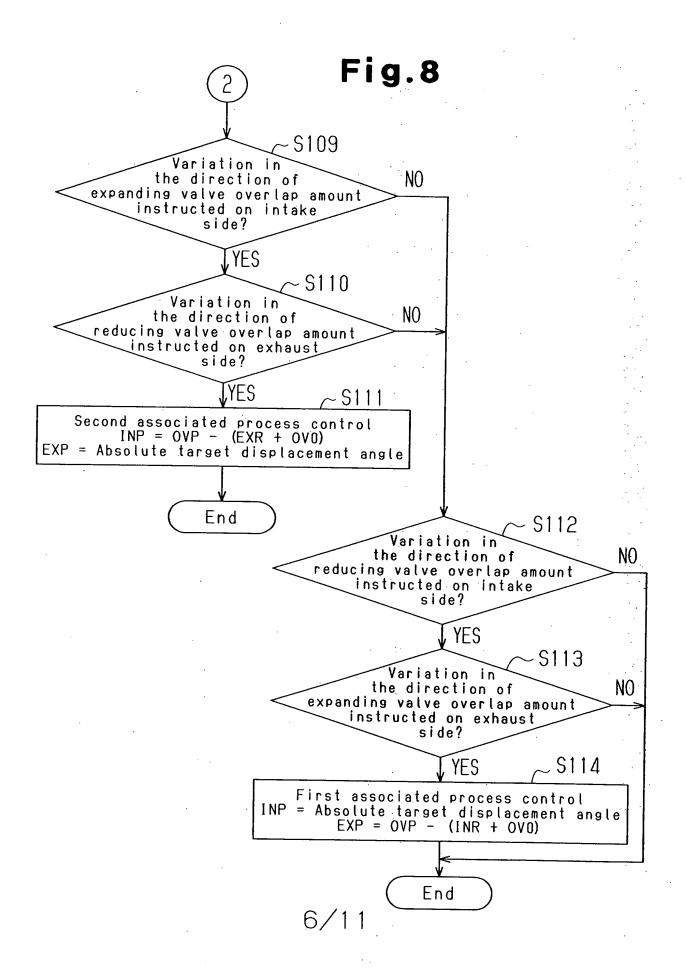EXP = Absolute target displacement angle

End

Fig.8

(2)

S109

Variation in the direction of expanding valve overlap amount instructed on intake side? — NO

YES

S110

Variation in the direction of reducing valve overlap amount instructed on exhaust side? — NO

YES

S111

Second associated process control
INP = OVP − (EXR + OVO)
EXP = Absolute target displacement angle

End

S112

Variation in the direction of reducing valve overlap amount instructed on intake side? — NO

YES

S113

Variation in the direction of expanding valve overlap amount instructed on exhaust side? — NO

YES

S114

First associated process control
INP = Absolute target displacement angle
EXP = OVP − (INR + OVO)

End

Actual displacement
angle INR

Target displacement
angle INP

Advance
↑

Fig.9(a)

Valve overlap amount
↕

Fig.9(b)

Target displacement
angle EXP

↓
Delayed

Actual displacement
angle EXR

Valve overlap
amount OVR

Fig.9(c)
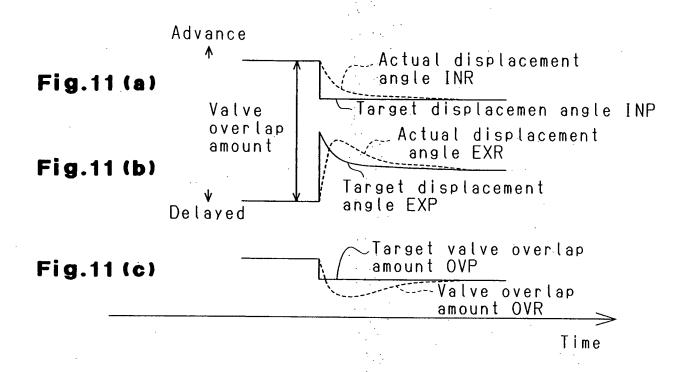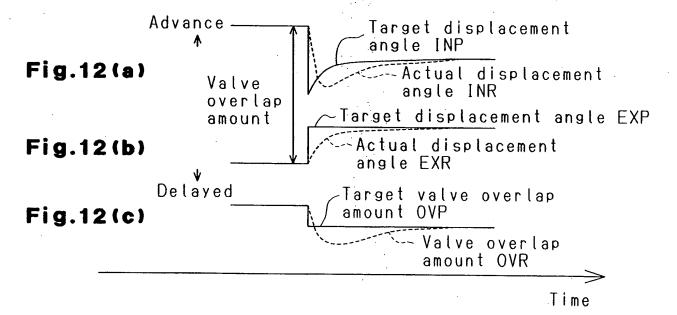
Target valve overlap
amount OVP

Time →

Advance
↑

Actual displacement
angle INR

Fig.10(a)

Target displacement
angle INP

Valve overlap amount
↕

Fig.10(b)

Actual displacement
angle EXR

↓
Delayed

Target displacement
angle EXP

Valve overlap
amount OVR

Fig.10(c)

Target valve overlap
amount OVP

Time →

7/11

10/525872

Fig.11(a)

Advance

Actual displacement
angle INR

Target displacemen angle INP

Valve
overlap
amount

Actual displacement
angle EXR

Fig.11(b)

Target displacement
angle EXP

Delayed

Fig.11(c)

Target valve overlap
amount OVP

Valve overlap
amount OVR

Time

Fig.12(a)

Advance
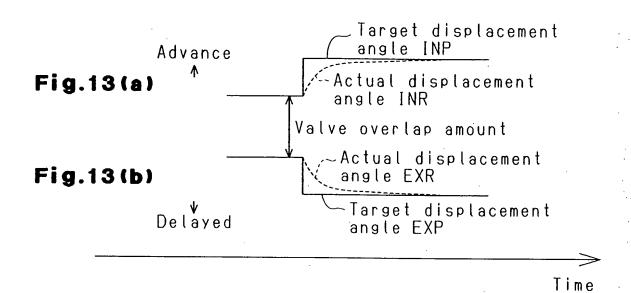
Target displacement
angle INP

Actual displacement
angle INR

Valve
overlap
amount

Target displacement angle EXP

Fig.12(b)

Actual displacement
angle EXR

Delayed

Fig.12(c)

Target valve overlap
amount OVP

Valve overlap
amount OVR

Time

8/11

Fig.13(a)

Advance ↑

Target displacement
angle INP

Actual displacement
angle INR

Valve overlap amount

Fig.13(b)

Actual displacement
angle EXR

Target displacement
angle EXP

Delayed ↓

Time →

Fig.14(a)

Advance ↑

Actual displacement
angle INR

Valve
overlap
amount

Target displacement angle INP

Fig.14(b)

Target displacement angle EXP

Actual displacement
angle EXR

Delayed ↓

Time →

Fig.15(a)

Fig.15(b)

Advance
↑

Target displacement
angle INP

Actual displacement
angle INR

Valve
overlap
amount

Target displacement
angle EXP

Actual displacement
angle EXR

↓
Delayed

Δt1

Time

Fig.16(a)

Fig.16(b)

Advance
↑

Target displacement
angle INP

Actual displacement
angle INR

Valve
overlap
amount

Target displacement
angle EXP

Actual displacement
angle EXR

↓
Delayed

Δt2

Time

Fig.17(a)

Advance

Target displacement angle INP

Valve overlap amount

Actual displacement angle INR

Fig.17(b)

Delayed

Actual displacement angle EXR

Target displacement angle EXP

Δt3

Time

Fig.18(a)

Advance

Target displacement angle INP

Valve overlap amount

Actual displacement angle INR

Fig.18(b)

Delayed

Actual displacement angle EXR

Target displacement angle EXP

Δt4

Time

11/11